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(54) **SEMICONDUCTOR DEVICE PACKAGE**

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H01L 21/50 (2006.01)

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See application file for complete search history.

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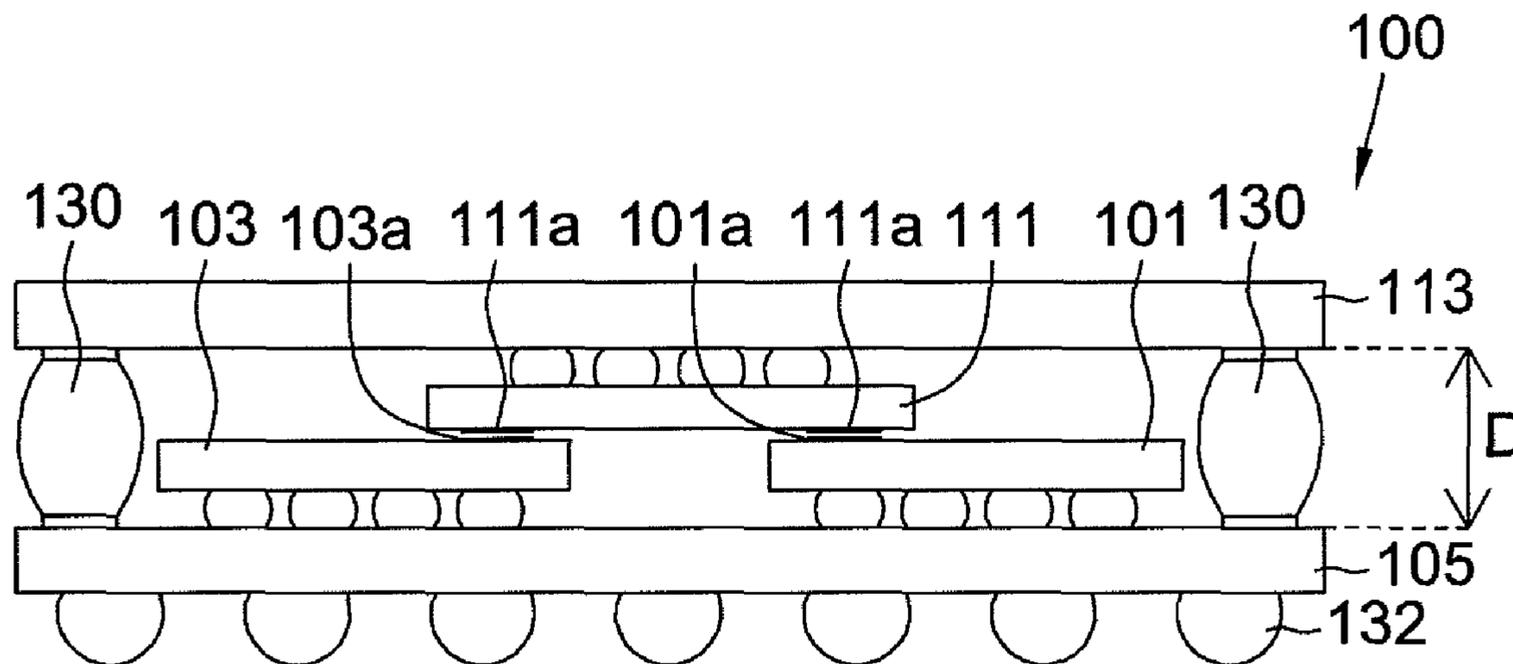
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(57) **ABSTRACT**

A first substrate has a first surface facing a second surface of the second substrate. The active chips are disposed on and electrically connected to the first surface, and spaced apart from each other by an interval, wherein the active chips respectively have a first active surface. The bridge chip is mechanically and electrically connected to the second surface, and has a second active surface partially overlapped with the first active surfaces of the active chips, such that the bridge chip is used for providing a proximity communication between the active chips. The connection structure is disposed between the first surface and the second surface for combining the first substrate and the second substrate.

15 Claims, 4 Drawing Sheets



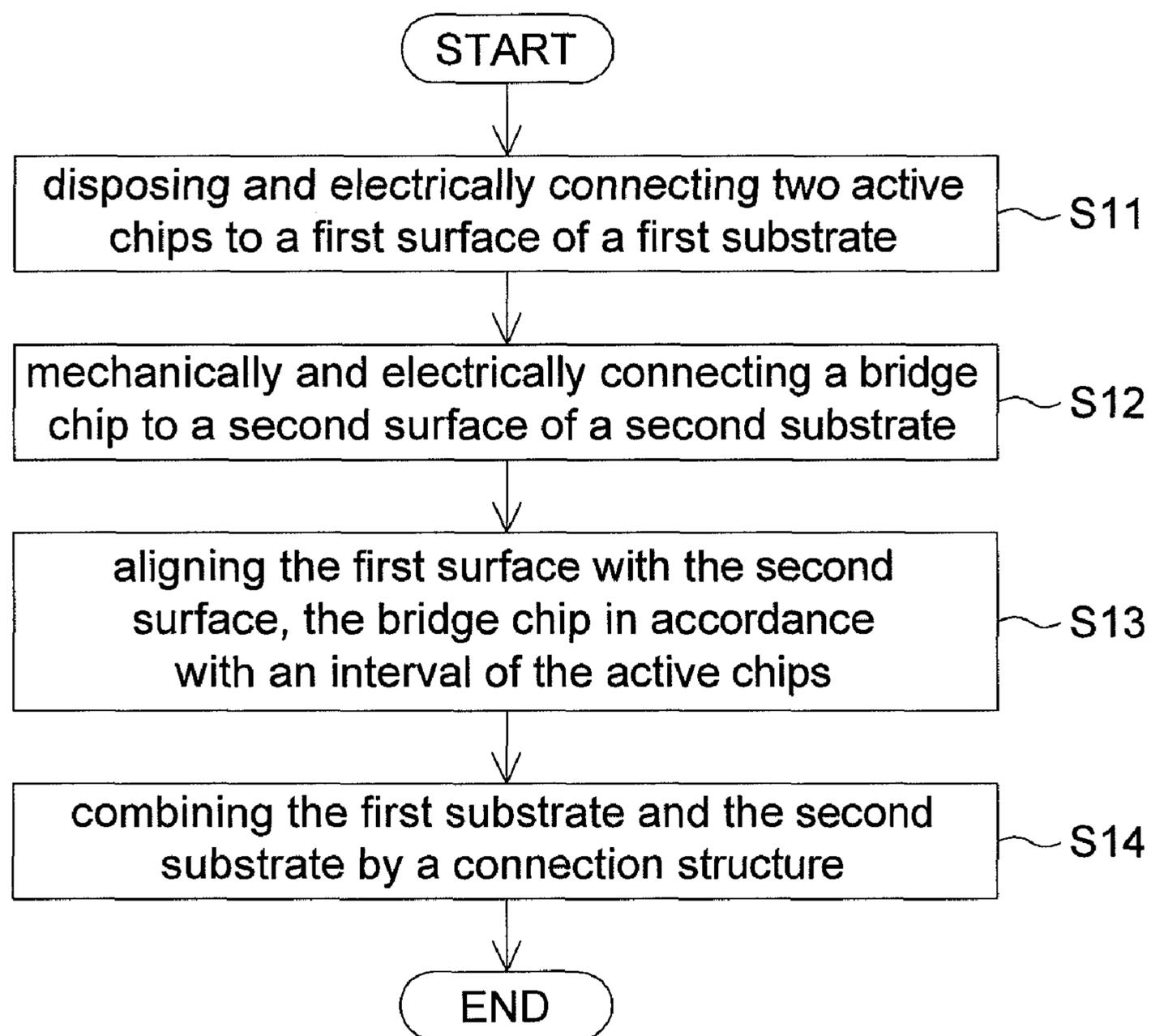


FIG. 1

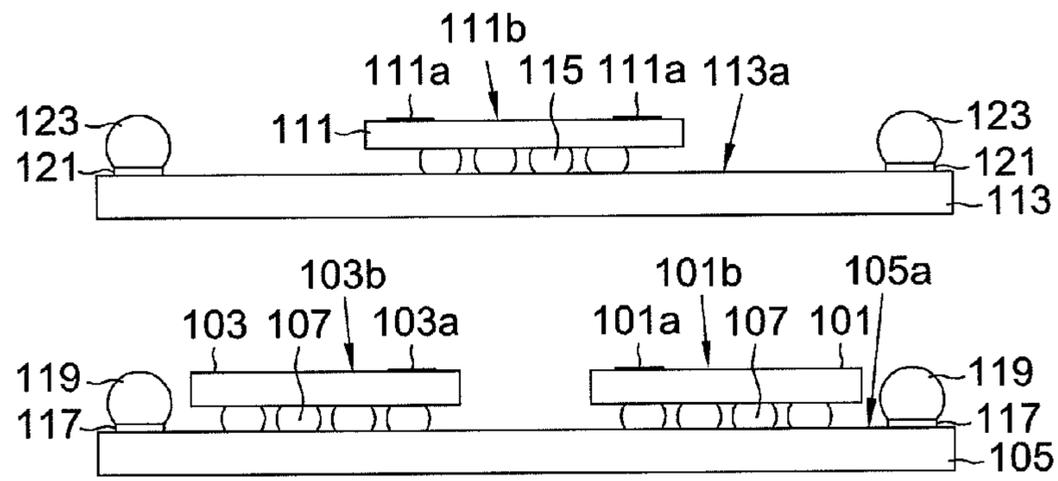


FIG. 2A

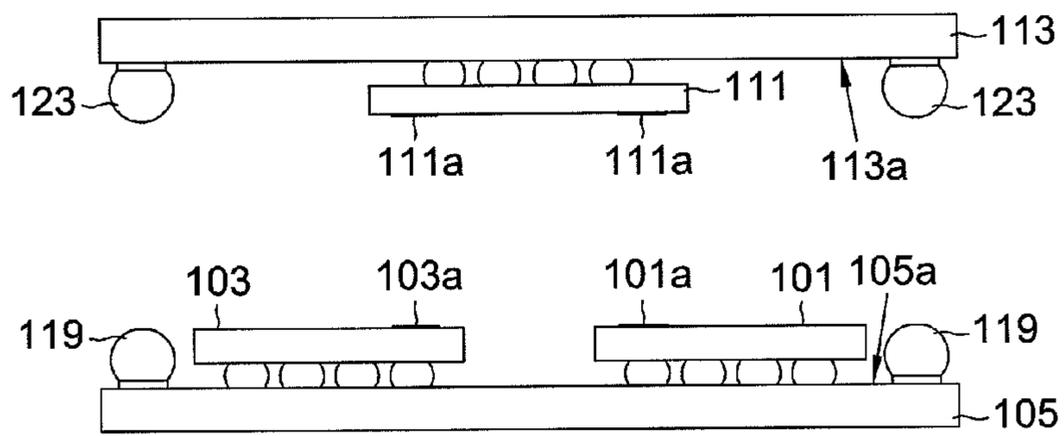


FIG. 2B

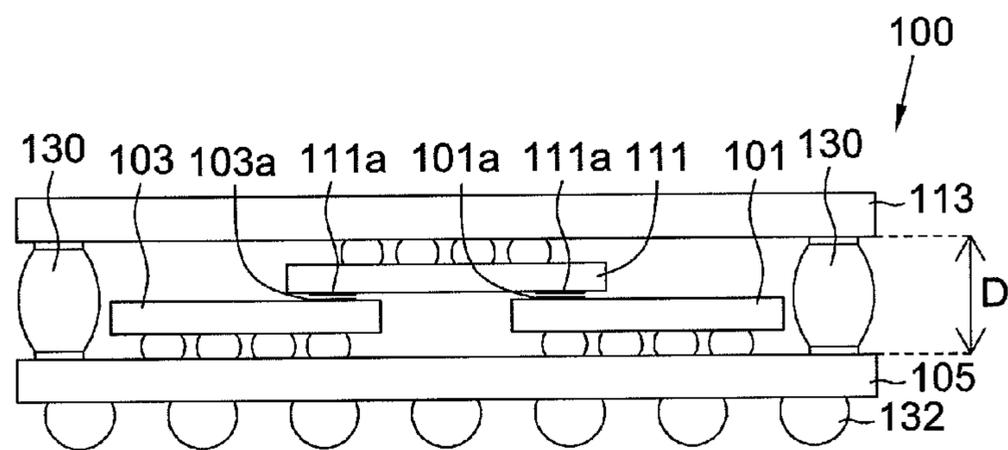


FIG. 2C

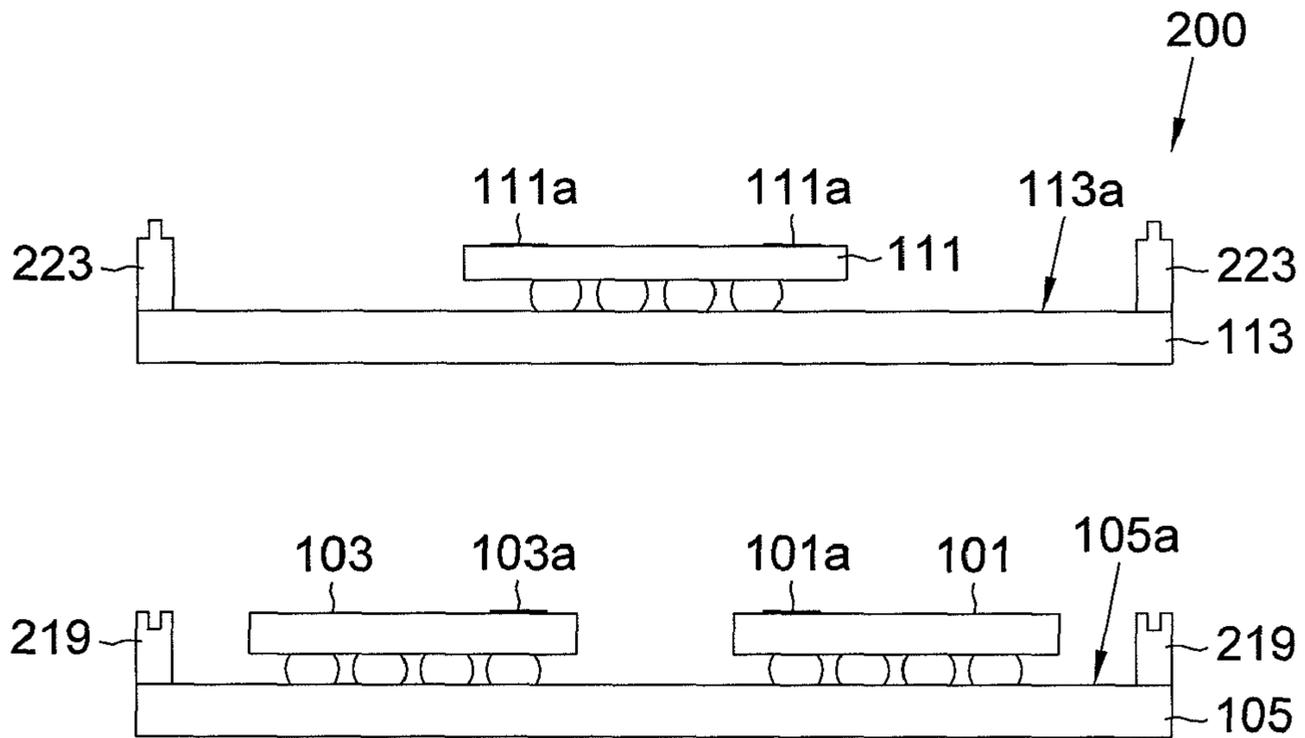


FIG. 3A

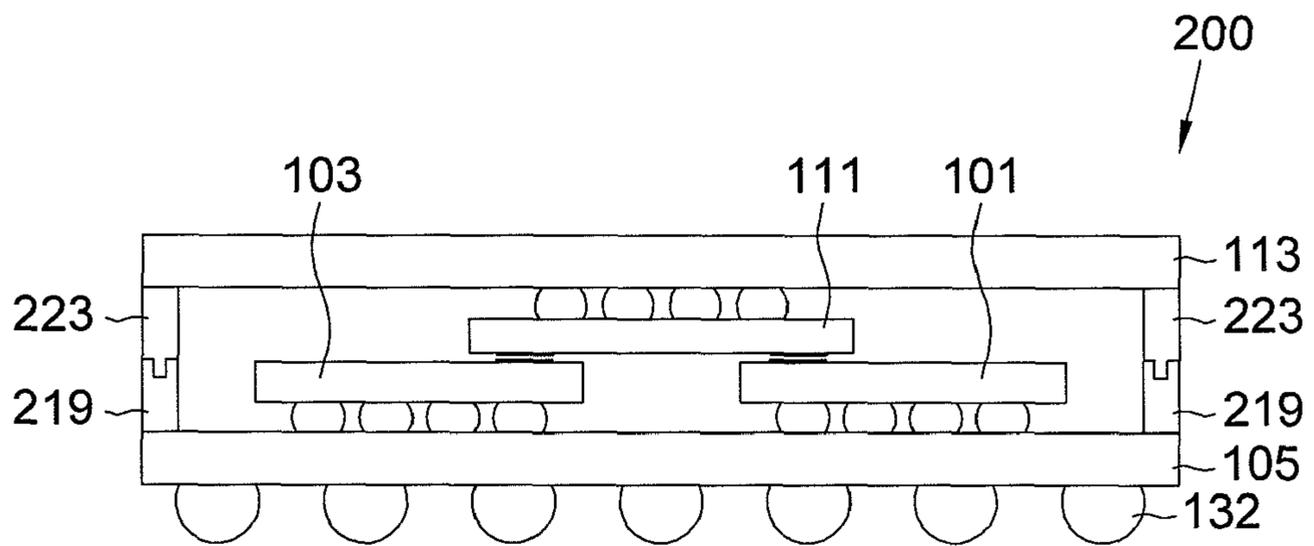


FIG. 3B

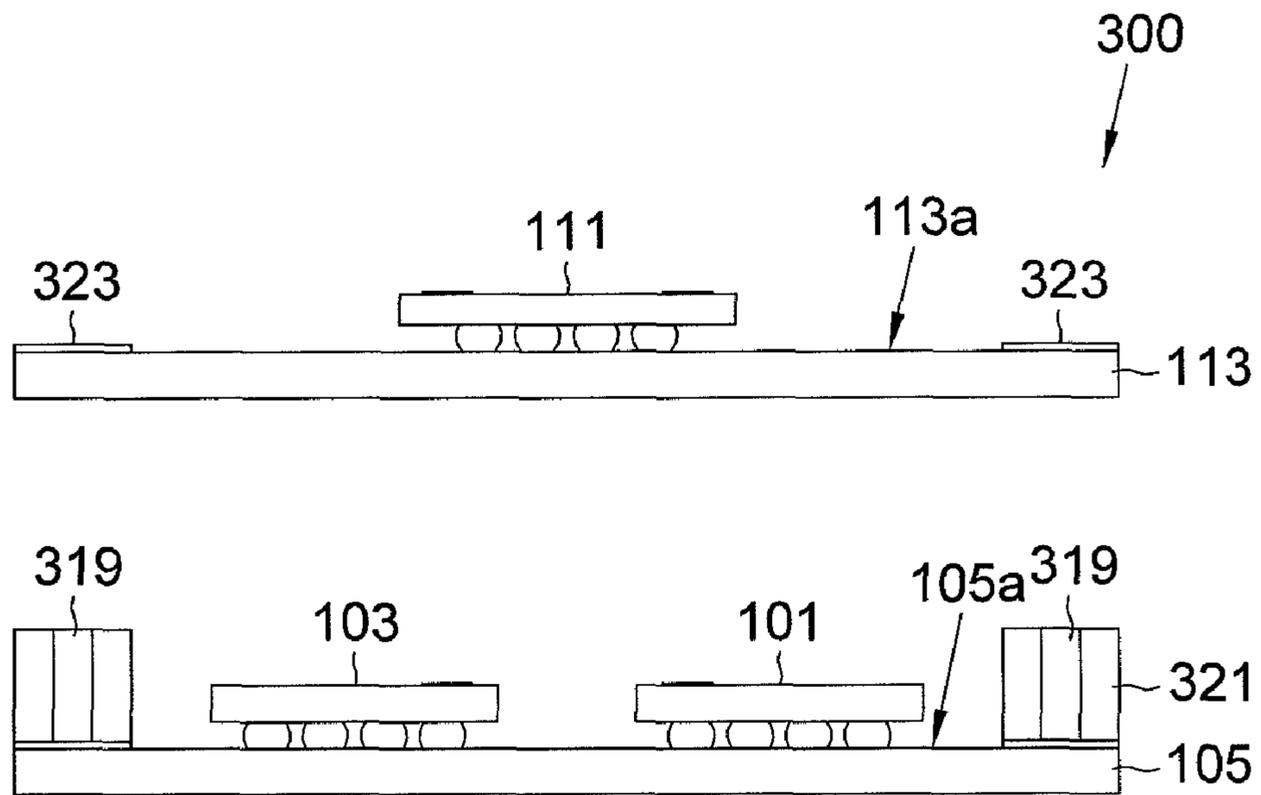


FIG. 4A

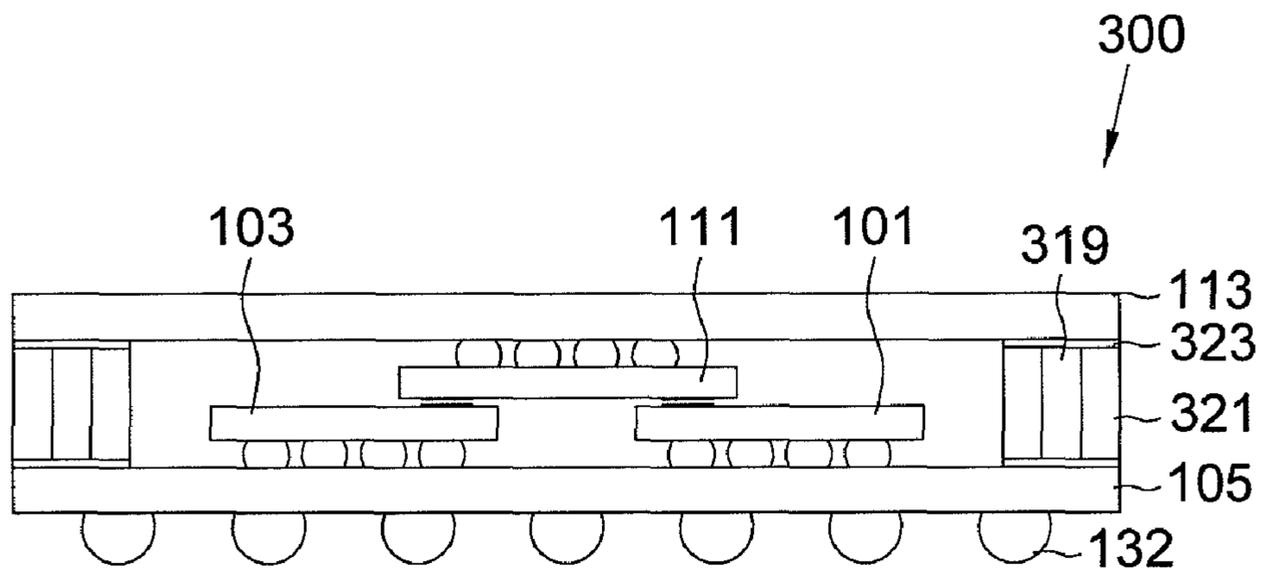


FIG. 4B

SEMICONDUCTOR DEVICE PACKAGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates in general to a device package, and more particularly to a semiconductor device package.

2. Description of the Related Art

At present, semiconductor industry has been developing and satisfying the requirement of the market. The structure of any semiconductor device demands precision and miniaturization when it comes to functionality of the semiconductor device. However, under some circumstances, the yield and quality of the semiconductor device is still difficult to control.

For example, integrated circuits (IC) packages have become more compact and require increased functions to be incorporated together. The increased logic functions on an IC package means an increase in circuit density of the IC package. As circuit density increases on the IC package, it becomes important to provide a reliable and robust packaging for forming the IC package. Also, the mechanical and electrical properties of such IC package need to be carefully considered without affecting the overall performance of the IC package.

Typically, the structure of any IC package or other semiconductor device package may be damaged due to, for example, cracks in the chips of the package when the chips are subjected to stress in the assembly process for the chips may be stressed when being directly moved by the suction nozzle to be coupled to other components.

Additionally, after assembling the chips, the structure of the IC package may be weakened due to invisible flaws on the chips and hence renders the IC package more susceptible to damages. Besides, damages on the chips adversely affect the integrity of the IC package, failing the test of the IC package. It is therefore desirable to provide a solution to address at least one of the foregoing problems of the conventional operations.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a semiconductor device package and its fabricating method which avoid direct handling to the chips of the semiconductor device package, preventing the damage to the chips because of fragility and improving the yield of the semiconductor device package.

The invention achieves the above-identified object by providing a semiconductor device package. The semiconductor device package includes a first substrate, a second substrate, two active chips, a bridge chip and a connection structure. The first substrate has a first surface facing a second surface of the second substrate. The active chips are disposed on and electrically connected to the first surface, and spaced apart from each other by an interval, wherein the active chips respectively have a first active surface. The bridge chip is mechanically and electrically connected to the second surface, and has a second active surface partially overlapped with the first active surfaces of the active chips, such that the bridge chip is used for providing a proximity communication between the active chips. The connection structure is disposed between the first surface and the second surface for combining the first substrate and the second substrate.

The invention achieves the above-identified object by providing a method of fabricating a semiconductor device package. The method includes the following steps: disposing and electrically connecting two active chips to a first surface of a first substrate; mechanically and electrically connecting a

bridge chip to a second surface of a second substrate; aligning the first surface with the second surface, the bridge chip in accordance with an interval of the active chips; and, combining the first substrate and the second substrate by a connection structure.

Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a flowchart of a method of fabricating a semiconductor device package according to a preferred embodiment of the invention;

FIGS. 2A~2C show a semiconductor device package according to the preferred embodiment of the invention;

FIGS. 3A~3B show a semiconductor device package according to another preferred embodiment of the invention; and

FIGS. 4A~4B show a semiconductor device package according to yet another preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a flowchart of a method of fabricating a semiconductor device package according to a preferred embodiment of the invention. The method includes steps S10~S14. FIGS. 2A~2C show a semiconductor device package according to the preferred embodiment of the invention.

As shown in step S11 and FIG. 2A, two active chips 101 and 103 are disposed and electrically connected to a first surface 105a of a first substrate 105. The active chip 101 has a plurality of first signal pads 101a formed on its first active surface 101b. The active chip 103 has a plurality of first signal pads 103a formed on its first active surface 103b. The active chips 101 and 103 are spaced apart from each other by an interval, and their backsides are electrically connected to the first surface 105a by a plurality of metal bumps 107, for example.

Then, as shown in step S12 and FIG. 2A, a bridge chip 111 is mechanically and electrically connected to a second surface 113a of a second substrate 113. The bridge chip 111 has a plurality of second signal pads 111a formed on its second active surface 111b, and the backside of the bridge chip 111 is electrically connected to the second surface 113a by a plurality of metal bumps 115.

For combining the first substrate 105 with the second substrate 113, a connection structure can be used and preferably supplied on the first substrate 105 and the second structure 113. As shown in FIG. 2A, the first substrate 105 has a plurality of first contact pads 117 disposed on the first surface 105a. A plurality of first solder balls 119, which are used as a part of the connection structure, are formed on the first contact pads 117. Likewise, the second substrate 113 has a plurality of second contact pads 121 disposed on the second surface 113a. A plurality of second solder balls 123, which are also used as a part of the connection structure, are formed on the second contact pads 121. Preferably, the first solder balls 119 are disposed around the active chips 101 and 103, and the second solder balls 123 are disposed around the bridge chip 111 and in accordance with the first solder balls 119.

After that, as shown in step S13 and FIG. 2B, the second substrate 113 is turned upside down, such that the first surface

105a is aligned with the second surface **113a**, the bridge chip **111** in accordance with the interval of the active chips **101** and **103**. Besides, the first solder balls **119** are positioned corresponding to the second solder balls **123**.

Then, as shown in step **S14**, the first substrate **105** and the second substrate **113** are combined by a connection structure. In this step, as the first solder balls **119** and the second solder balls **123** are in contact with each other, a reflow process is applied to the whole structure, such that the metal material of the first solder balls **119** and the second solder balls **123** is melted. After the reflow step, the metal material is cooled down such that the first solder balls **119** and the second solder balls **123** are integrated to form a plurality of solder balls **130** of the connection structure as shown in FIG. 2C, and the first substrate **105** and the second substrate **113** are therefore combined to form a semiconductor device package **100**.

In the semiconductor device package **100**, the distance **D** between the first substrate **105** and the second substrate **113** is precisely controlled such that the first signal pads **101a** and **103a** are spaced apart from the second signal pads **111a** but the first signal pads **101a** and **103a** and the second signal pads **111a** are in proximity connection, which renders the second signal pads **111a** of the bridge chip **111** to be capacitively or inductively coupled to the first signal pads **101a** and **103a** of the active chips **101** and **103**. As the active chips **101** and **103** and the bridge chip **111** are sealed between the first substrate **105** and the second substrate **113**, the electrical connection of the chips **101**, **103** and **111** to external components such as semiconductor devices, circuit boards or controllers (drivers) can be accomplished by a plurality of solder balls **132** disposed on and electrically connected to the backside surface of the first substrate **105** or the second substrate **113**. The connection structure for combining the first substrate **105** and the second structure **113** is consisted of the solder balls **130** however the invention is not limited thereto.

FIGS. 3A~3B show a semiconductor device package according to another preferred embodiment of the invention. The semiconductor device package **200** is different from the semiconductor device package **100** in the connection structure, so the same elements are assigned with the same reference numbers and not elaborated again.

The active chips **101** and **103** and the bridge chip **111** are respectively formed on the first substrate **105** and the second substrate **113** before combining the first substrate **105** with the second substrate **113**. Beside, a plurality of first connectors **219** are formed on the first surface **105a** and around the active chips **101** and **103**. A plurality of second connectors **223** are formed on the second surface **113a** and positioned in accordance with the first connectors **219**. The first connectors **219** and the second connectors **223** are respectively female connectors and male connectors, such that the first connectors **219** and the second connectors **223** can be coupled to each other.

Likewise, the second substrate **113** is turned upside down, such that the first surface **105a** is aligned with the second surface **113a**, the bridge chip **111** is in accordance with the interval of the active chips **101** and **103**, and the first connectors **219** are positioned corresponding to the second connectors **223**. Then, as shown in FIG. 3B, the first substrate **105** and the second substrate **113** are combined by the connection structure consisting of the first connectors **219** and the second connectors **223** attached to the first connectors **219**. Moreover, a plurality of solder balls **132** can be disposed on and electrically connected to the backside surface of the first substrate **105** or the second substrate **113** for electrically

connecting the chips **101**, **103** and **111** to external components such as semiconductor devices, circuit boards or controllers (drivers).

FIGS. 4A~4B show a semiconductor device package according to yet another preferred embodiment of the invention. The semiconductor device package **300** is different from the semiconductor device package **100** in the connection structure, so the same elements are assigned with the same reference numbers and not elaborated again.

As shown in FIG. 4A, a plurality of passive components **319** are mechanically and electrically connected to the first surface **105a** of the first substrate **105** at locations around the active chips **101** and **103**. The passive components **319** can be capacitors, resistors or inductors. Furthermore, a solder material **321** is disposed around each of the passive components **319**. In accordance with the passive components **319**, a plurality of contact pads **323** are formed on the second surface **113a** of the second substrate **113**. When combining the first substrate **105** and the second substrate **113**, the second substrate **113** is firstly turned upside down such that the second surface **113a** is opposite to the first surface **105a**, the bridge chip **111** is aligned with the interval of the active chips **101** and **103**.

Then, at least the first substrate **105** or the second substrate **113** is moved until the passive components **319** and the solder material **321** are in contact with the contact pads **323**. After that, a reflow process is applied to the whole structure so as to melt the solder material **321**. As the solder material **321** is cooled down, the contact pads **323** are attached to the solder material **321** as well as the passive components **319**, and the first substrate **105** is connected to the second substrate **113**. For electrically connecting the chips **101**, **103** and **111** to external components such as semiconductor devices, circuit boards or controllers (drivers), a plurality of solder balls **132** can be disposed on and electrically connected to the backside surface of the first substrate **105** or the second substrate **113**.

In the embodiment, the combination of the first substrate **105** and the second substrate **113** includes the step of turning the second substrate **113** upside down however the invention is not limited thereto. It can also be the first substrate **105** to be flipped in the fabricating process.

The semiconductor device package and the method of fabricating the semiconductor device package according to the preferred embodiment of the invention are disclosed above. When fabricating the semiconductor device package, the active chips and the bridge chip are firstly formed on two separate substrates, and the components of the connection structure are also formed on the substrates around the active chips and the bridge chip. Then, one substrate having the active chips or the bridge chip is reversed to face and be combined with the other substrate via the connection structure. After the substrates are combined together, accordingly, the assembly, positioning and electrical connection of the active chips and the bridge chip are completed without employing additional tools to directly catch the active chips and the bridge chip during the fabricating process. Thus, compared to the conventional method of fabricating a semiconductor device package using a suction nozzle to catch and move the chips when assembling the chips, the semiconductor device package and the method of fabricating the semiconductor device package according to the preferred embodiment of the invention avoid the direct handling to the chips, thus prevent the problem of damaging the chips due to the fragility of the chips.

While the invention has been described by way of example and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is

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intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A semiconductor device package, comprising:
 - a first substrate having a first surface;
 - a second substrate having a second surface facing the first surface;
 - two active chips disposed on and electrically connected to the first surface, wherein the active chips are spaced apart from each other by an interval, and the active chips respectively have a first active surface;
 - a bridge chip mechanically and electrically connected to the second surface, wherein the bridge chip has a second active surface, the second active surface is partially overlapped with the first active surfaces of the active chips, the bridge chip is used for providing a proximity communication between the active chips; and
 - a connection structure disposed between the first surface and the second surface for combining the first substrate and the second substrate, wherein the connection structure comprises a plurality of passive components.
2. The semiconductor device package according to claim 1, wherein:
 - each of the active chips has a plurality of first signal pads formed on the first active surface;
 - the bridge chip has a plurality of second signal pads formed on the second active surface;
 - at least some of the second signal pads of the bridge chip are capacitively or inductively coupled to at least some of the first signal pads of the active chips.
3. The semiconductor device package according to claim 1, further comprising a plurality of metal bumps connecting to the active chips and the first surface.
4. The semiconductor device package according to claim 1, further comprising a plurality of metal bumps connecting to the bridge chip and the second surface.
5. The semiconductor device package according to claim 1, wherein the connection structure is disposed around the active chips and the bridge chip.
6. The semiconductor device package according to claim 1, wherein the connection structure comprises a plurality of solder balls.
7. The semiconductor device package according to claim 1, wherein the connection structure comprises at least two male connectors and at least two female connectors coupled to each other.

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8. The semiconductor device package according to claim 7, wherein the female connectors are disposed on the first substrate, the male connectors are disposed on the second substrate.

9. The semiconductor device package according to claim 1, wherein the passive components are capacitors, resistors or inductors.

10. The semiconductor device package according to claim 1, further comprising a plurality of solder balls disposed on a third surface of the first substrate opposite to the first surface.

11. A semiconductor device package, comprising:

- a first substrate having a first surface;
- a second substrate having a second surface facing the first surface;
- two active chips disposed on and electrically connected to the first surface, wherein the active chips are spaced apart from each other by an interval, and the active chips respectively have a first active surface;
- a bridge chip mechanically and electrically connected to the second surface, wherein the bridge chip has a second active surface, the second active surface is partially overlapped with the first active surfaces of the active chips, the bridge chip is used for providing a proximity communication between the active chips;
- a plurality of passive components mechanically and electrically connected to the first surface of the first substrate; and
- a solder material disposed around each of the passive components.

12. The semiconductor device package according to claim 11, further comprising a plurality of contact pads on the second surface of the second substrate, wherein the passive components and the solder material are in contact with the contact pads.

13. The semiconductor device package according to claim 11, wherein:

- each of the active chips has a plurality of first signal pads formed on the first active surface;
- the bridge chip has a plurality of second signal pads formed on the second active surface;
- at least some of the second signal pads of the bridge chip are capacitively or inductively coupled to at least some of the first signal pads of the active chips.

14. The semiconductor device package according to claim 11, further comprising a plurality of metal bumps connecting to the active chips and the first surface.

15. The semiconductor device package according to claim 11, further comprising a plurality of metal bumps connecting to the bridge chip and the second surface.

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